MULTIMEDIA UNIVERSITY

STUDENT ID NO

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# MULTIMEDIA UNIVERSITY

# FINAL EXAMINATION

**TRIMESTER 3, 2015/2016**

## EPM1076 – INTRODUCTION TO MACHINES AND POWER SYSTEMS

( TE, RE, BE )

1 JUNE 2016
2:30 p.m – 4:30 p.m
( 2 Hours )

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**INSTRUCTIONS TO STUDENTS**

1. This Question paper consists of 4 pages excluding cover page with 4 Questions only.

2. Attempt **ALL** questions in the Question Paper. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please write all your answers in the Answer Booklet provided.

## QUESTION 1

(a) State and briefly explain the principle that describes the operation of a generator.
[4 marks]

(b) Given a Y - Δ system, determine the magnitude of generator phase voltage and load phase voltage if line voltage is measured as 200V.
[4 marks]

(c) State the main components that form a basic transformer.
[3 marks]

(d) A 250V, 1kW, 4 poles, 60Hz, Y-connected induction motor has a full load slip of 5%. Determine the rotor speed and rotor frequency of this motor at the rated load.
[6 marks]

(e) In a typical power system, the electrical power is generated by harvesting the current available natural energy resources. Name such two energy resources that produce less pollution to the environment.
[4 marks]

(f) List down four basic components of a simple protection scheme in power system.
[4 marks]

**Continued .....**

## QUESTION 2

(a) A ferromagnetic core with relative permeability of 1300 is shown in Figure Q2a. The depth of the core is 4cm. An air gap of 0.3mm is found on the right side of the core. Due to fringing effect, the effective area of the air gap is 15% larger than its physical size. Two coils of wire are wrapped around the core with $N_1 = 600$ and $N_2 = 300$ turns. The coil currents are $i_1 = 0.4$A and $i_2 = 0.5$A. Determine the total magnetic flux.

[15 marks]

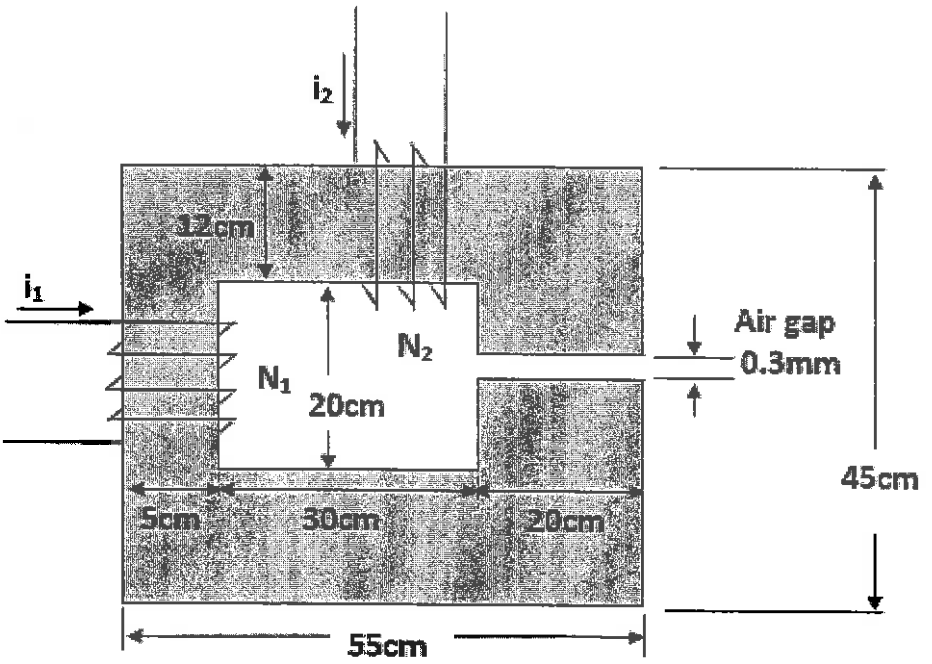


**Figure Q2a**

(b) Three identical load impedances $Z_\Delta = 10 + j17.32\Omega$ are connected in delta to a balanced three phase Y-connected source by three identical line cables. Given that the magnitude of line voltage is 300V, calculate the:

i) Magnitude of load current in each phase.
ii) Total real power of the loads.
iii) Total reactive power of the loads.
iv) Total apparent power of the loads.
v) Power factor of the load.

[2 + 2 + 2 + 2 + 2 marks]

**Continued .....**

## QUESTION 3

(a) A 25-kVA 4000/277-V, 60Hz single phase transformer has the following resistances and reactances:

Primary winding resistance, $R_p$ =32Ω
Secondary winding resistance, $R_s$ = 0.05Ω
Primary winding reactance, $X_p$ = 45Ω
Secondary winding reactance, $X_s$ = 0.06Ω
Core resistance, $R_c$ =250kΩ
Magnetizing reactance, $X_m$ =30kΩ

i) Find the approximate equivalent circuit of this transformer referred to primary and then draw the equivalent circuit.
ii) Determine the primary voltage of the transformer if secondary voltage is 277V at 0.7 lagging power factor.

[7 + 8 marks]

(b) DC test, open circuit test and short circuit test were conducted on a 250kVA, 450V, 60Hz, Y-connected synchronous generator. The tests results are shown in the table below:

**Table Q3b**

| DC test | Open circuit test | Short circuit test |
|---|---|---|
| DC voltage, $V_{DC}$ = 8V<br>DC current, $I_{DC}$ = 20A | Open circuit line terminal voltage, $V_{OC,L}$ = 560V | Short circuit line current, $I_{SC}$ = 280A |

i) Determine the per phase armature resistance.
ii) Determine the per phase synchronous reactance.
iii) Sketch the per phase equivalent circuit of this synchronous generator.

[2 + 5 + 3 marks]

**Continued .....**

## QUESTION 4

(a) Draw a per unit reactance diagram for the system shown in Figure Q4a. Given that new base power of 20MVA and new base voltage of 22kV are chosen for generating region.

[14 marks]

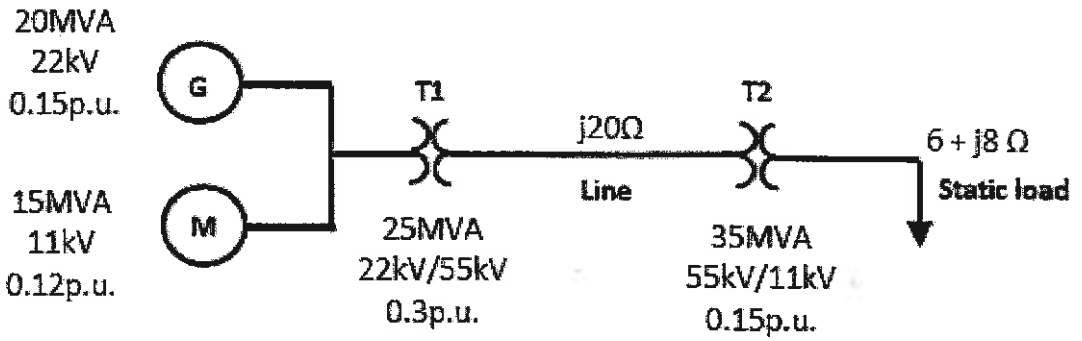


**Figure Q4a**

(b) Figure Q4b shows a distribution system protection scheme using IDMT relay. Assume the plug setting current (PS) to be 1A for both relay A and B. The CB operating time is 0.4 sec. TMS of relay B is 0.1. PSM versus the operating time (T) is provided in table Q4b. Determine the TMS and operating time of relay A for fault at Bus C.

[11 marks]

**Table Q4b**

| PSM | 20 | 15 | 10 | 5 |
|---|---|---|---|---|
| T (sec) | 2.2 | 2.6 | 3.2 | 4.3 |

Operating time of relay = T* TMS

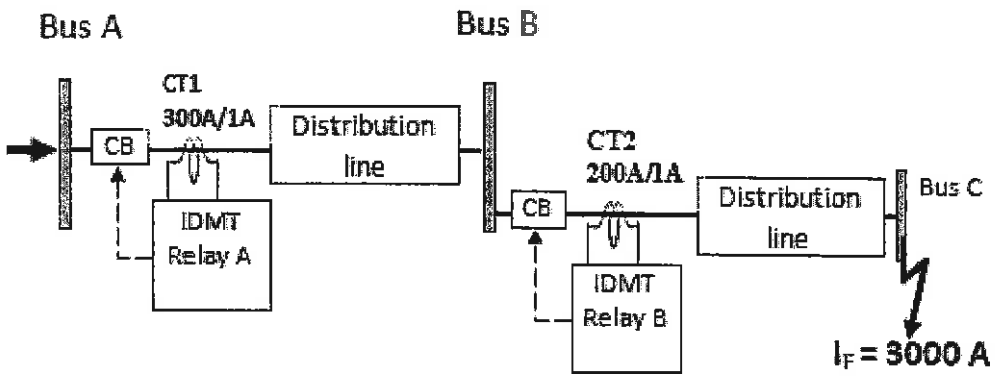


**Figure Q4b**

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